

Letters to the Editor: Response to Helias Udo de Haes *

Key Elements in a Framework for Land Use Impact Assessment Within LCA

Llorenç Milà i Canals^{1**}, Ruedi Müller-Wenk², Christian Bauer³, Jochen Depestele⁴, Alain Dubreuil⁵, Ruth Freiermuth Knuchel⁶, Gérard Gaillard⁶, Ottar Michelsen⁷ and Bernt Rydgren⁸

¹ Centre for Environmental Strategy, University of Surrey (D3), GU2 7XH Guildford (Surrey), UK

² Institut für Wirtschaft und Ökologie, Universität St. Gallen, Tigerbergstrasse 2, 9000 St. Gallen, Switzerland

³ Forschungszentrum Karlsruhe, Department for Technology-Induced Material Flows (ITC-ZTS), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

⁴ Institute for Agricultural and Fisheries Research – Animal Sciences – Fisheries, Ankerstraat 1, 8400 Oostende, Belgium

⁵ Natural Resources Canada, 555 Booth Street, K1A 0G1 Ottawa, Ontario, Canada

⁶ Agroscope Reckenholz-Tänikon Research Station ART, Reckenholzstr. 191, 8046 Zürich, Switzerland

⁷ Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology (NTNU), 7491 Trondheim, Norway

⁸ Vattenfall Power Consultant AB, Box 1842, 581 17 Linköping, Sweden

** Corresponding author (L.MiC@surrey.ac.uk)

DOI: <http://dx.doi.org/10.1065/2006.12.296>

Introduction

Milà i Canals and co-authors (2007) (from now on referred to as MiC) have recently published 'Key elements in a framework for land use impact assessment within LCA'¹. One of the goals of this paper was to initiate a debate on how to assess land use impacts in LCA, and Udo de Haes (2006) (UdH) reacted with a Letter to the Editor in the July 2006 issue of *Int J LCA*: 'How to Approach Land Use in LCIA or how to avoid the Cinderella effect?'* The CML report 171 (Guinée et al. 2006) was referenced as a background document explaining in more detail some of UdH's critical comments. UdH makes several proposals and suggestions that are not directly linked to the contents of MiC; we welcome all new inputs to the debate, but will limit our response in this letter to those points of UdH directly relevant to MiC:

- UdH misses a definition of land use impacts in MiC.
- Do the selected impact pathways (land use to biodiversity; land use to biotic production potential; land use to ecological soil quality) fit in the methodological structure of LCA?
- Provided that the answer to the above is positive, is it admissible to include only these 3 impact pathways in a method and to eliminate all other impacts due to land use?
- Why squeeze land use into the framework of LCA when other existing approaches may address land use impacts in a more convenient way?

In the following sections, we address the above-mentioned aspects (Sections 1–4), and offer some conclusions in Section 5.

1 Definition of Land Use Impacts

In the first place, UdH misses a definition of land use impacts in the paper by MiC and co-workers; such definition is nevertheless offered in section 2 of MiC: land use impacts "represent a land quality difference during a certain time". That is, land use impacts are the 'amount' of land quality not present in a certain area due to the studied system, compared to a situation where the studied system had not been established. Additionally, and in contrast to what UdH suggests as a definition, land use impacts may also represent chemical changes in the environment (e.g. change in soil's salts composition, change in soil organic carbon, etc.).

2 Do Land Use Impacts Fit in the Methodological Structure of LCA?

2.1 The choice of the environmental intervention(s): one-time habitat transformations

UdH proposes excluding land transformations from LCA insofar as they are non-concomitant to the land-based production of the economic output ('product'). His argument is that such transformation impacts are generally not allocable to the product, because there is no scientific justification to fix the length of the productive occupation period subsequent to the preparatory land transformation.

Response: Practically all unit processes of the economic system require preparatory processes. Whilst grain production may require preliminary drainage or deforestation of the future crop field, metal production or electricity generation

*DOI: <http://dx.doi.org/10.1065/lca2006.07.257> [*Int J LCA* 11 (4) 219–221 (2006)]

¹ It should be noted that the paper was first published on-line in May 2006 (DOI: <http://dx.doi.org/10.1065/lca2006.05.250>); the paper version can be found in this issue, pp 5–15.

are preceded by the setting up of a technical infrastructure (buildings, machinery, dams, site preparation, etc.). This means that an exclusion of preparatory processes in general from LCA, due to their less direct allocability to the subsequent production quantity, would seriously jeopardise the usability of LCA as a decision tool. Guinée et al. (2006) does not propose such a general exclusion, and includes explicitly in LCA the provision of equipment and machines as required for executing land management procedures (Guinée et al. 2006: I16–I20). It is important to state here that the problem of allocating the environmental effects of building a tractor to the functional unit is the same as allocating a land transformation like drainage of the future cropland. The allocation of this initial transformation processes is not dealt with in MiC². There is no scientific way to predict the future of markets; as a consequence, a 'clear' allocation of preparative interventions to the future years of useful life of the created structure has to be based on societal agreements, to avoid arbitrariness. International accounting standards or tax regulations provide instructions for fixing useful lives for all types of investments including transformation of agricultural/silvicultural or mining land. These standards are socially accepted, at least in the finance world (IFRS 2004), so there are no reasons why the corresponding 'useful life' data should not be used in the context of LCA.

2.2 Space generic vs. space-dependent analysis

We cannot share UdH's opinion that the bio-geographical differentiation suggested by MiC does not qualify for LCA because it is not 'generic regarding space'. Space-dependent characterisation factors penetrate more and more into the framework of LCA. If the emission of 1 kg SO₂ in Northern Sweden is not treated in the same way as in Southern Sweden (Finnveden and Nilsson 2005), it is not justified to exclude land use impacts on biodiversity from LCIA, with the argument that paving 1 km² for 70 km of motorway in Northern Sweden has a different influence on biodiversity than paving 1 km² in Southern Sweden for the same purpose.

2.3 Steady state analysis and the transient effects of land use on biodiversity

UdH states that LCA is primarily a steady-state tool, which seems to express the view that LCA does not reflect temporary environmental effects from emission or extraction pulses as registered in a LCI. However, this probably does not mean that effects varying in time are not eligible for LCA, because it seems to be clear that environmental effects that are intensive in the first years after an emission pulse and become negligible 100 or 500 years after emission can well be included in LCA by means of an integration over time of effects being a function of time (Udo de Haes et al. 1999: sect. 3.3).

² Milà i Canals et al. (2007) do not recommend allocation over a period of 100 years as interpreted by UdH.

Response: Land use impacts are essentially temporary: biodiversity on a land area influenced by a land transformation or land occupation in year 1 will show a strong reaction in the first years but will fade away decades after the end of the transformation or occupation, due to the forces of nature that will not reproduce the original state of the land but a new state that may show a comparable biodiversity. We suggest that the time-dependent reaction of biodiversity or soil quality within a given perimeter, as caused by a 'pulse' of land use, is very much comparable to the time-dependent reaction of the atmosphere's radiative forces and its consequences on human health and biodiversity. There are no reasons, under the title of time behaviour, to include in LCA the latter and to exclude the former. In both cases, it is appropriate to express the environmental effect as a mean magnitude of impact during a time period: a suppression of N (or n%) species on an area A during time t, or a mean annual loss of N human life years during time t.

2.4 The choice of the impact indicator

UdH understands that the toxicity impact indicators like PDF or PAF are recommended by MiC as indicators for biodiversity, and states that they are not practical for expressing the biodiversity impact of land use on a given plot of land.

Response: We do NOT propose to use PDF as the indicator for biodiversity impacts of land use. In fact, MiC's paper does not recommend any specific indicator for the described impact pathways because it is not the aim of the paper to provide an operational method, but to frame the problem of assessing land use impacts in LCA. Some criteria to select biodiversity and soil quality indicators are provided in Milà i Canals et al. (2006).

3 Is it Admissible to Include in a Method only 2 or 3 Impact Pathways and to Leave away all Other Impacts?

UdH criticises "the narrowing down to just three main types of impact related to land use" in MiC.

Response: First, we do not say that LCA has to be limited to three impact pathways originating from land use. Whoever feels that additional impact pathways are needed in order to obtain a reasonable completeness of LCA, is invited to publish the corresponding supplementary proposals. Second, the impact pathways mentioned in MiC are a reasonably selected starting position for LCIA in land use, and they actually include many of the aspects mentioned by UdH, except possibly the effects on the water table which are not direct effects on the land quality. In fact, we can document that biologists consider land use as the main problem of biodiversity degradation, that land use since year 1850 is a main cause of the change in radiative forcing, and that UNEP sees inappropriate land use as a main cause for the observable reduction of the globe's capacity to sustainably produce useful biomass. If our capacity to develop

LCIA of land use is limited, there are good rationales to address the impact pathways mentioned in our proposal as a first priority.

4 Environmental Impacts from Land Use to be Included in Other Tools, Instead of LCA?

UdH suggests keeping most of the impacts from land use away from LCA and treating these within other tools, like Environmental Risk Assessment, or procedures for awarding Sustainability Labels.

Response: In view of the difficulties to solve the problems with land use in LCA, it would of course be nice to exclude land use from LCA and hand over the problems to other people. However, if somebody wants to compare a synthetic shirt with a cotton shirt using LCA, UdH's proposal would result in a seriously incomplete, over-all impact for the cotton shirt because the environmental impacts from growing cotton would be mostly absent, so that the synthetic product might appear environmentally worse. If the cotton production was certified by a 'Sustainable Agriculture Initiative Platform', UdH would probably suggest mentioning this certificate in the LCA. But this would in no way help to find out whether cotton or oil is environmentally preferable as a shirt material.

Not only clothing but a growing variety of other products can be produced either from land-based resources or abiotically-based ones. It is essential to develop LCA into a tool that can deal with the corresponding decisions.

5 Concluding Remarks

Land use impacts have received increasing attention in LCA studies in the last years, but an agreed assessment framework and methods are still lacking. The debate on this issue needs to continue, bearing in mind that LCA results will be incomplete and less credible as long as land use impacts are not being incorporated, particularly for such hot topics as the comparison of products and services based on biotic system vs. those based on abiotic ones.

We agree with Udo de Haes that other approaches and tools may provide more detailed information than LCA on effects of different land management practices. However, LCA is the appropriate tool "to bring a life cycle perspective to support complex decisions" (Milà i Canals et al. 2006) involving many different land uses, and, consequently, it should incorporate a measure of the different impact pathways affected by land use.

One of the aspects that UdH suggests can be (and is currently) "incorporated as an impact category in itself" is the surface area needed for different activities³. It is indeed better to consider the 'area time' (e.g. m²year) used than not mentioning land use at all in the LCA results. However, different management practices (and indeed biotic-based vs. abiotic-based systems) differ in their effects on land quality by orders of magnitude, and therefore the m²year used by different activities cannot be simply added without any characterisation. Staying with the addition of this elementary flow would be like suggesting the addition of kg of CO to kg of dioxins under the category 'toxic emissions': this may have been a good first step in the early 1990s, but it would not be admitted in an LCA study today, given our current level of knowledge. We think it is now time to take one step beyond also for land use impacts.

Acknowledgements. Critical comments on a previous version of this letter by Prof Olivier Jolliet are kindly appreciated.

References

- Finnveden G, Nilsson M (2005): Site-dependent Life-Cycle Impact Assessment in Sweden. *Int J LCA* 10 (4) 235–239
- Guinée JB, Van Oers L, De Koning A, Tamis W (2006): Life cycle approaches for Conservation Agriculture. Research commissioned by Syngenta Crop Protection AG, Basel. CML report 171, CML, Leiden. Downloadable from <<http://www.leidenuniv.nl/cml/ssp/index.html>>
- IFRS (2004): International Financial Reporting Standards 2004, International Accountings Standards Board, London UK
- Milà i Canals L, Bauer C, Depestele J, Dubreuil A, Freiermuth Knuchel R, Gaillard G, Michelsen O, Müller-Wenk R, Rydgren B (2007): Key elements in a framework for land use impact assessment in LCA. *Int J LCA* 12 (1) 5–15
- Milà i Canals L, Clift R, Basson L, Hansen Y, Brandão M (2006): Expert Workshop on Land Use Impacts in Life Cycle Assessment (LCA). 12–13 June 2006 Guildford, Surrey (UK). *Int J LCA* 11 (5) 363–368
- Udo de Haes HA (2006): How to Approach Land Use in LCIA or How to avoid the Cinderella effect? Comments on 'Key Elements in a Framework for Land Use Impact Assessment Within LCA'. *Int J LCA* 11 (4) 219–221
- Udo de Haes HA, Jolliet O, Finnveden G, Hauschild M, Krewitt W, Müller-Wenk R (eds), Baitz M, Braunschweig A, Castells F, Ciroth A, Crettaz P, Ekvall T, Goedkoop M, Guinée J, Heijungs R, Hertwich EG, Hofstetter P, Klöpffer W, Kunst H, Lindeijer E, Matsuno Y, Milà i Canals L, Irving Olsen S, Pennington DW, Potting J, Seppälä J, Sonnemann GW, Taylor T, Tukker A, Weidema B (1999): Best Available Practice Regarding Impact Categories and Category Indicators in LCIA. *Int J LCA* 4 (3) 167–174

³ It should be noted that UdH refers to LCIA in his comment, but this indicator is actually an LCI result.